GRINDSTONE FLAT AND BIG FLAT EXCLOSURES — A 41-YEAR RECORD OF CHANGES IN CLEARCUT ASPEN COMMUNITIES

W.F. MUEGGLER and D.L. BARTOS

USDA Forest Service Research Paper INT-195
INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE

USDA Forest Service
Research Paper INT-195
October 1977

GRINDSTONE FLAT AND BIG FLAT EXCLOSURES — A 41-YEAR RECORD OF CHANGES IN CLEARCUT ASPEN COMMUNITIES

W.F. MUEGGLER and D.L. BARTOS

INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
Forest Service
U.S. Department of Agriculture
Ogden, Utah 84401

THE AUTHORS

WALTER F. MUEGGLER, Principal Plant Ecologist, has been with the Intermountain Station since 1949. He is currently Leader of the Aspen-Mountain Grassland Ecology research work unit at Logan, Utah. He obtained his B.S. degree from the University of Idaho, M.S. degree from the University of Wisconsin, and a Ph.D. degree in Plant Ecology from Duke University.

DALE L. BARTOS is a Range Scientist at the Forestry Sciences Laboratory, Logan, Utah. He joined the Intermountain Station in 1972. Bartos holds B.S. and M.S. degrees from Fort Hays State University, and a Ph.D. degree in Range Science from Colorado State University. His principal research interest is systems modeling.

CONTENTS

Page

PREFACE iv

SETTING 1

APPROACH 2

EVALUATION 3

Response of Trees 3
Response of Browse 8
Response of Understory Vegetation 10

MANAGEMENT IMPLICATIONS 14

PUBLICATIONS CITED 16

RESEARCH SUMMARY

Deer browsing prevented aspen regeneration in both uncut stands and small 1/20-hectare clearcuts, even though nearby large burns regenerated successfully. Size of the clearcut or burned area may be critical in determining success of aspen regeneration; areas less than about 2 hectares in size may adversely concentrate deer use. Shrub production was less under deer use and forb production was less under cattle use than on protected areas. More aspen suckers were produced in uncut stands where cattle grazed than in stands protected from grazing, suggesting a possible relationship between sucker initiation and reduced competition from the herbaceous understory. Removal of aspen cover changed herbaceous composition from forb to grass dominants and discouraged conifer invasion.

PREFACE

Opportunities sometimes exist to gain considerable insight into long-term effects of management on vegetation by remeasuring old administrative studies and exhuming from the files data collected during the early stages of the study. Such was the case with the Grindstone Flat and the Big Flat deer and cattle exclosures discussed in this report. A few days spent collecting current data and in perusing old files have permitted us to trace the influence of clearcutting and of deer and cattle on plant succession in two stands of aspen over a period of 41 years.

We wish to acknowledge the contribution of the Fishlake National Forest personnel involved in establishing the plots and in gathering data over the decades. H. M. Christensen apparently was instrumental in starting the study in 1934. Data were collected by R. J. Costley, and W. E. Augsbach in 1937, by W. L. Robinette in 1942, and by E. R. Doman, and O. Julander in 1949. A rough-draft report prepared by E. R. Doman, D. I. Rasmussen, and H. M. Christensen in 1959 provided helpful background information on the area and assisted interpretation of the early data.

SETTING

Beaver Mountain is a high plateau on the Fishlake National Forest in southern Utah that rises to more than 3,650 m (12,000 ft) elevation at its highest points. Large expanses of aspen *(Populus tremuloides)* dominate the elevations between 2,400 and 3,000 m (8,000 to 10,000 ft). Mixed stands of spruce *(Picea engelmannii)* and fir *(Abies lasiocarpa)* are common on northerly exposures and at higher elevations. Many large grassy openings intermixed with the aspen and conifer communities contribute to the diversity of vegetation types. Historically this area has been important summer range for both deer *(Odocoileus hemionus)* and livestock.

Deer apparently were abundant in about 1865 when Beaver County was first settled, for the pioneers had little difficulty keeping themselves supplied with venison. Soon after settlement, the summer ranges on Beaver Mountain were heavily stocked with sheep and cattle. Livestock overgrazing and unrestricted hunting apparently caused deer numbers to decline to a low from 1900 to 1910. The combined effect of placing Beaver Mountain under National Forest administration in 1906 with better regulation of forage use and the enactment of a "buck law" by the Utah legislature in 1913 with enforcement of hunting regulations permitted the deer populations to increase markedly. Excessive use of aspen suckers and palatable shrubs by 1926 was attributed to high populations of deer. By 1934, aspen regeneration was poor over large areas of Beaver Mountain. Overuse of the summer range coincided with overuse of browse on adjacent winter ranges on both the east and west sides of Beaver Mountain. As a result, antlerless deer hunts were begun in 1934 to control population numbers.

Overuse of the livestock summer range on Beaver Mountain was recognized as a serious problem in the early 1930's. Cattle and sheep, as well as the deer, were considered too numerous. Overgrazing in the extensive aspen type was of particular concern. Proposed reductions in livestock grazing were protested by ranchers who blamed the deer for depleted forage conditions. This dispute resulted in the establishment of study plots on aspen range within cattle allotments to demonstrate the relative effects of deer and cattle grazing on the forage and on aspen regeneration.

APPROACH

Two sets of plots were located in aspen types on the Beaver District of the Fishlake National Forest. One set was established near the lower edge of the aspen zone at about 2,590 m (8,500 ft) elevation on Grindstone Flat (sec. 29, T. 29 S., R. 4 W.); the other set was placed near the upper edge of the aspen zone on Big Flat (sec. 18, T. 29 S., R. 4 W.) at about 3,200 m (10,500 ft) elevation. Each set of plots consisted of about a 30- by 60-m (100- by 200-ft) deer exclosure where the vegetation was protected from use by all ungulates, an adjacent area of like size that excluded livestock but was open to deer use, and an adjacent area open to use by both deer and livestock. Three-fourths of each exclosure was clearcut of aspen; the aspen was left intact in the remaining fourth. The areas were cut and pole fences constructed in the fall of 1934.

Aspen sprouts and other vegetation were first measured in 1937, 3 years after the plots were established. A single, permanent 23.8-m^2 (4.88- by 4.88-m; 16- by 16-ft) quadrat was established on the cleared and uncleared portion of each exclosure and on the range adjacent to the exclosures. Vegetation canopy cover below 1.68 m (5-1/2 ft) in height was determined for each species on these quadrats. In addition, individual stems of trees and shrubs on the quadrats were counted. Vegetation measurements on these quadrats were repeated in 1942, in 1949, and in 1975. Such measurements enable tracing the sequence of successional change after cutting and of change attributable to protection from grazing.

Measurements confined to a single 4.88- by 4.88-m quadrat provided a restricted and questionable overall sample of treatment effects. Consequently, we expanded our sampling in 1975 to include estimates of productivity and composition of understory vegetation and counts of aspen numbers by size-class distribution over the entire treatment plots. Understory production was determined from three sets of five 1/2-m^2 quadrats randomly distributed over each treatment plot. The current year's biomass for plants on each of four quadrats was estimated as a percent of the fifth; the fifth was then clipped to ground level, dried, and weighed. The percentage estimates were then converted to weights and the average of the 15 quadrats converted to kilograms dry weight per hectare. Biomass composition by vegetation class and by individual species was estimated for each five-quadrat set and averaged for each treatment. Aspen and conifer trees were counted by size classes on a 0.0202-hectare (1/20-acre) strip within each treatment. Trees representing different size classes in each treatment were then cored and aged.

Reliable data on changes in deer and cattle grazing pressure on the study sites over the 41-year period are not available. We know, however, that judicious management dictated reduction in numbers of both species from their high levels early in the century. We also know that the general area continued to support substantial numbers of deer and cattle over the study period. Interpretation of vegetation differences between treatments is therefore based upon the presence or absence of cattle versus deer use rather than on absolute changes in animal numbers.

EVALUATION

Understory vegetation at the Grindstone Flat site near the lower edge of the aspen zone is appreciably different from that at Big Flat near the upper edge of the aspen zone. For example, shrubs are fairly abundant in the aspen understory at Grindstone Flat, but are lacking at Big Flat. The two areas, therefore, cannot be considered true replications for evaluating treatment effects on understory vegetation. However, those species common to both areas might be expected to respond similarly to like treatments.

Although each study site at Grindstone and Big Flat appeared to be environmentally uniform, the vegetation was not sampled before clearcutting or exclosure construction to verify uniformity between treatment plots. Consequently, we must assume that subsequent differences in vegetation between plots on a site result from treatment effects and not from initial dissimilarities in vegetation between plots.

RESPONSE OF TREES

In 1975, the oldest aspen measured at Grindstone Flat was 172 years old (40.6 cm d.b.h., 17.4 m in height); the oldest at Big Flat was 126 years (35.3 cm d.b.h., 15.2 m in height). Thus, the stands were at least 131 and 85 years old, respectively, when the study began in 1934. We also found trees on both areas that were between 30 and 60 years old in 1934. Judging from the concern about lack of aspen regeneration in the early 1930's, we can assume that few trees were less than 30 years old on the study sites in 1934. Apparently very few of the aspen suckers that arose between 1905 and 1934 were able to escape browsing and become trees.

The persistent occurrence of suckers over the years despite animal use is evidenced by the number of suckers in 1975 less than 0.5 m tall on the uncut plots continually used by deer and cattle (table 1). Under continued use, approximately 7,000 suckers per hectare occurred at Grindstone Flat and 26,000 per hectare at Big Flat. Most of these suckers were heavily utilized. In 1942 and in 1949, approximately 3,000 suckers (less than 1.68 m in height) per hectare occurred on the Grindstone Flat plots and 14,000 to 30,000 per hectare occurred on the Big Flat plots in these years, respectively (table 2). Judging from the lack of aspen reproduction in the 0.5 m tall to 5.1-cm d.b.h. size class on these grazed plots in 1975 (table 1), few of these suckers were able to escape and become saplings.

Table 1.--*Numbers of aspen and conifers by size classes on the Grindstone and Big Flat plots in 1975, 41 years after establishment.*

Size class	Grindstone Flat					Big Flat				
	Uncut			Cut		Uncut			Cut	
	Closed to use	Deer use only	Deer and cattle use	Closed to use	Deer use only	Closed to use	Deer use only	Deer and cattle use	Closed to use	Deer use only
	- - - - - - - - - - Number/0.0202 hectare transect - - - - - - - - - -									
<0.5 m tall										
Populus tremuloides	19	10	[1]145	16	6	142	47	525	116	0
Conifers[2]	9	6	28	9	1	15	21	27	9	3
0.5-2 m tall										
P. tremuloides	37	8	0	89	0	92	0	1	87	0
Conifers	4	9	13	6	5	32	31	14	16	6
2 m tall-<5.1 cm d.b.h.										
P. tremuloides	60	0	0	45	0	118	5	8	251	0
Conifers	5	5	6	2	1	16	6	6	4	4
5.1-10.2 cm d.b.h.										
P. tremuloides	63	20	22	173	0	20	19	18	28	0
Conifers	4	6	4	6	0	4	0	6	0	1
10.2-15.2 cm d.b.h.										
P. tremuloides	22	12	45	8	0	4	9	18	0	0
Conifers	3	0	3	1	1	0	0	2	0	1
15.2-20.3 cm d.b.h.										
P. tremuloides	6	5	19	0	0	3	7	3	0	0
Conifers	0	4	3	1	1	0	0	0	0	0
20.3-25.4 cm d.b.h.										
P. tremuloides	1	0	2	0	0	4	7	6	0	0
Conifers	0	0	3	0	0	0	0	0	0	1
25.4-30.5 cm d.b.h.										
P. tremuloides	1	0	1	0	0	1	0	0	0	0
Conifers	0	1	0	0	0	0	0	0	0	1
>30.5 cm d.b.h.										
P. tremuloides	0	2	6	0	0	0	0	0	0	0
Conifers	0	0	0	0	0	0	0	0	0	0

[1]Almost all were heavily utilized.

[2]Approximately 90 percent of conifers at Grindstone Flat were *Abies lasiocarpa*; at Big Flat, approximately 70 percent were *A. lasiocarpa*, and 30 percent were *Picea engelmannii; Pinus albicaulis* and *Pseudotsuga menziesii* also occurred.

As expected, clearcutting greatly stimulated production of aspen suckers. The third growing season (1937) after cutting, the ungrazed clearcut plot had approximately 26 times as many suckers as the ungrazed uncut plot at Grindstone Flat, and approximately 19 times as many at Big Flat (table 2). By 1942, 8 years after cutting, such large differences were no longer apparent. Many of the suckers on the ungrazed clearcut either grew into saplings or were reduced by natural thinning (fig. 1A). By 1975, over three-fourth of the aspen stems on the ungrazed clearcut plots at both areas were over 0.5 m tall, and approximately 60 percent were over 2 m tall (table 1, fig. 1B).

Table 2.--*Changes in number of stems and canopy cover of browse (aspen and shrubs under 1.68 m in height) on permanent 23.8 m² quadrats at Grindstone Flat and Big Flat between 1937 (3 years after establishment) and 1975.*

Location and species	1937		1942		1949		1975	
	Number of stems	Canopy cover	Number of stems	Canopy cover	Number of stems	Canopy cover	Number of stems	Canopy cover
		Percent		*Percent*		*Percent*		*Percent*
UNCUT								
CLOSED TO USE								
Grindstone Flat								
Populus tremuloides	14	12.2	84	17.1	22	6.4	4	2.5
Rosa woodsii	75	[1]--	136	6.3	108	--	12	1.0
Symphoricarpos vaccinioides	--	3.3	--	6.8	25	10.8	77	3.9
Big Flat								
P. tremuloides	9	4.1	54	7.9	63	17.4	7	5.5
DEER USE ONLY								
Grindstone Flat								
P. tremuloides	28	2.2	11	.1	32	.3	4	.4
R. woodsii	84	.1	71	.9	75	--	23	1.2
S. vaccinioides	14	12.9	--	9.2	93	17.0	88	5.9
Big Flat								
P. tremuloides	--	1.1	--	.1	39	.1	54	2.9
DEER AND CATTLE USE								
Grindstone Flat								
P. tremuloides	0	0	7	.3	7	.1	2	.2
R. woodsii	91	.1	161	1.8	109	--	8	.2
S. vaccinioides	1	1.2	4	1.5	5	1.1	7	.4
Big Flat								
P. tremuloides	41	--	34	.2	71	.1	25	1.4
CUT								
CLOSED TO USE								
Grindstone Flat								
P. tremuloides	369	63.8	113	40.5	--	--	8	2.3
R. woodsii	54	.4	81	2.5	--	--	12	.6
S. vaccinioides	--	11.8	--	15.7	--	--	74	3.7
Big Flat								
P. tremuloides	170	51.9	151	50.2	--	--	27	14.1
DEER USE ONLY								
Grindstone Flat								
P. tremuloides	12	6.6	0	0	--	--	0	0
R. woodsii	9	.2	35	.5	--	--	1	.1
S. vaccinioides	3	2.0	16	1.6	--	--	25	1.0
Big Flat								
P. tremuloides	17	.2	0	0	--	--	0	0

[1] A dash indicates missing data.

A

B

Figure 1.--The clearcut area at Grindstone Flat protected from all ungulate use showing (A) amount of reproduction in 1942, 8 years after cutting, and (B) subsequent development of the aspen stand by 1975, 41 years after cutting.

A

B

Figure 2.--The Grindstone Flat exclosure in (A) 1942 and (B) 1975 showing the clearcut area open to deer use only, and clearcut closed to all ungulate use. Note the original uncut aspen stand in the background of figure 2A.

Although we have no record of sucker production the first two growing seasons after clearcutting, we have no reason to believe that initial stimulation of sucker production would differ between the plots open and closed to deer use. By 1937, the effect of deer use on sucker mortality in the clearcuts was strikingly evident (table 2); the plot open to deer use at Grindstone Flat had only 3 percent as many suckers as the protected plot and the one at Big Flat had only 10 percent as many suckers as the protected plot. By 1942, neither the Grindstone nor the Big Flat clearcut plots used by deer contained either aspen suckers or aspen saplings (fig. 2A). The extensive data collected in 1975 (table 1) show that, although a few small suckers were found on the cut plot open to deer at Grindstone Flat, none were found at Big Flat.

Some aspen suckers still arose at the edges of the clearcuts adjacent to the uncut plots and adjacent to the cut but protected plots that contained 40-year-old trees. Invariably, these suckers were heavily browsed by deer and remained less than about 30 cm tall. Suckers were seldom found more than about 4 m from the edge of the cut. A striking exception was an aspen tree, approximately 10 cm d.b.h. that grew well into the grazed clearcut at Grindstone Flat. This tree was enclosed by 1 m tall wire net fencing. Apparently, the tree was enclosed as a sucker and so escaped browsing.

Generally, aspen suckers were able to develop into saplings and perpetuate the aspen stands on these small plots only when protected from deer browsing (fig. 2). This was true for both the cut and uncut plots at both Grindstone and Big Flats. Despite deer use, small suckers continued to occur in uncut stands, but were invariably suppressed by heavy browsing. In contrast, suckers were usually present in grazed clearcuts for only a few years after cutting, probably because the small, heavily browsed suckers were unable to keep alive the extensive root system (the sucker source) of the cut trees.

Approximately 10 times as many small suckers continued to occur on the uncut plots used by both deer and cattle as on those used by deer alone (table 1). This might be related to reduced herbaceous understory where cattle grazed (table 3). Competitive relationships might have been altered sufficiently to stimulate aspen suckering.

Deer and cattle use apparently did not directly affect the success or persistence of conifer regeneration. However, conifer reproduction appeared considerably more successful in those stands with an aspen overstory than those without (fig. 3). In 1975, the clearcut, but regenerated aspen plots, contained over 2 times as many conifers less than 10.2 cm d.b.h. as those clearcut plots without an aspen overstory (table 1). Thus, deer use can indirectly impede conifer establishment by preventing a clearcut from going back to aspen cover. This lends credence to the belief that aspen commonly serves as a nurse crop for conifers. The plots at Big Flat contained almost 1-1/2 times as many conifers as those at Grindstone Flat, but this is attributed primarily to elevational and seed source differences.

RESPONSE OF BROWSE

Aspen reproduction less than 1.68 m in height constitutes the primary browse at both Grindstone Flat and Big Flat; aspen foliage above this level is not considered available to deer. Snowberry (*Symphoricarpos vaccinioides*) and rose (*Rosa woodsii*) are important browse species on Grindstone Flat, but such shrubs are lacking on Big Flat. Thus, ample aspen reproduction is critical both for maintaining viable aspen stands and as a source of browse for deer.

Table 3.--*Production and composition of understory vegetation on the Grindstone Flat and Big Flat aspen plots in 1975, 41 years after establishment*

Understory vegetation	Grindstone Flat					Big Flat				
	Uncut			Cut		Uncut			Cut	
	Closed to use	Deer use only	Deer and cattle use	Closed to use	Deer use only	Closed to use	Deer use only	Deer and cattle use	Closed to use	Deer use only
	Dry kilograms/hectare									
TOTAL	714	920	392	978	1,474	843	1,024	356	395	780
Shrubs	228	74	24	78	118	0	0	0	0	0
Graminoids	21	340	94	68	766	101	72	114	47	546
Forbs	464	506	274	831	590	742	952	242	348	234
	Percent composition by weight									
SHRUBS										
Berberis repens		4	1							
Rosa woodsii	2	T	1	T	T					
Symphoricarpos vaccinioides	30	4	4	8	8					
GRAMINOIDS										
Agropyron caninum	T	2	1	1	2			T		5
Bromus anomalus	2	30	17	2	2	2	5	10	T	8
Carex spp.	T	T	1	1		7	1	2	3	5
Festuca idahoensis						3	1	20	8	38
Poa fendleriana		3			7	T	T	T	1	4
Sitanion hystrix		T		T	3					1
Stipa comata				1	18					
Stipa lettermani	1	2	4		20					5
Stipa occidentalis						1				3
FORBS										
Achillea lanulosa	T	2	2	1	1	T	3	8	3	8
Agoseris glauca					T		T		2	1
Astragalus bourgovii	3	T	35	2			4	20		
Castilleja linariaefolia	10	T	T	12		13		T	T	
Cirsium undulatum	18	20	12	15	4	T	T		T	2
Erigeron speciosus	1	5		2	22	T				
Fragaria americana	T	3	4	5	T	8	6	10	12	1
Frasera speciosa	12	T		3		10	2	10	18	1
Helenium hoopesii	T				T	7	4	10	T	10
Helianthella uniflora	8	T		6	1					
Lupinus leucophyllus	5	20	15	30	7	37	71	8	46	1
Potentilla pulcherrima	T	T	T	T	2	3	T	T	3	1
Smilacina stellata	7		T							
Solidago decumbens						7	1	2	1	T
Taraxacum officinale	T	2		2	2	1	1	T	2	2
Thalictrum fendleri		T	T	7						
Other herbs	T	T	T	T	T	T	T	T	T	4

In the mid-1930's, aspen reproduction under 1.68 m tall was scarce on Grindstone Flat. The 1937 data from the uncut plot open to cattle and deer use, however, indicated that suckers still occurred with some abundance at Big Flat (table 2). The amount of aspen browse on these uncut areas open to use by both cattle and deer did not change appreciably over the years. Even the relatively numerous aspen suckers on the 23.8 m^2 quadrat at Big Flat in 1975 (over 10,000 per hectare) did not provide much more than 1 percent crown cover. This suggests that even though sprouting ability persisted over the years, the small and spindly sprouts provided relatively little browse.

Barring cattle, but not deer, somewhat benefited aspen browse production. After 41 years of deer use only, crown coverage of aspen browse was about 3 percent on Big Flat, but still less than one-half percent on Grindstone Flat.

Figure 3.--Conifer invasion under an uncut aspen stand at Grindstone Flat in 1975.

Eliminating both cattle and deer use on the uncut areas apparently enabled both sucker numbers and aspen foliage to increase for 10 to 15 years following protection (table 2). Browse production then declined as the aspen suckers grew above the 1.68-m available browse height. After 41 years of protection from grazing, aspen browse covered over 5 percent of the Big Flat plot and over 2 percent of the Grindstone Flat plot. Although foliage mass was greater on the protected than on the grazed plots, sucker numbers were not. This suggests that the protected suckers were large and vigorous, whereas the suckers on the grazed plots, though perhaps more numerous, were small and weak.

The amount of rose and snowberry on the permanent quadrats fluctuated greatly over the years under all grazing and cutting treatments (table 2). However, the extensive data obtained in 1975 (table 3) indicate that deer use of the uncut stands markedly reduced both of these shrubs, particularly the snowberry.

RESPONSE OF UNDERSTORY VEGETATION

The single 4.88- by 4.88-m permanent quadrat placed in each treatment and sampled over the years provided a very restricted and probably invalid sample of response on each area because of initial dissimilarity of vegetation on these small quadrats (tables 4 and 5). We believe the extensive 1975 production inventory (table 3) gives a more precise account of species response to grazing treatment as identified by differences accumulated over the 41-year period. The 1975 production inventory is therefore used as a main indicator of species response to grazing, with the permanent quadrats used to provide supplementary information on successional changes. Additionally, only the

Table 4.--*Changes in cover composition (%) of vegetation under 1.68 m in height on permanent 23.8 m^2 quadrats at Grindstone Flat between 1937 (3 years after establishment) and 1975.*

Understory vegetation	Closed to use				Deer use only				Deer and cattle use			
	1937	1942	1949	1975	1937	1942	1949	1975	1937	1942	1949	1975
UNCUT												
Total shrubs and trees	25	45	37	38	35	30	37	20	3	20	6	15
Total graminoids	37	23	26	4	35	35	54	25	5	15	6	15
Total forbs	38	32	37	58	30	35	9	55	92	65	88	70
Abies lasiocarpa	T	2	6	25		1	2	4	T	1	2	13
Achillea lanulosa				1	1	T	T	1	3	8	3	1
Agropyron caninum					T	6	6	7	1		T	T
Astragalus bourgovii	T		T		6	22	1	2	55	44	78	35
Bromus anomalus	5	6	4			1	1	12			T	10
Carex spp.	6	7	4		25	9	10	T	1	7	T	
Castilleja linariaefolia		1	4	2				T				
Cirsium undulatum	1	2	2	15	2		T	8	T	1	1	14
Erigeron speciosus	2		1	4	1			2				
Fragaria americana				T					30	3	2	5
Frasera speciosa		T		6	T	1	1	1	T		T	1
Helianthella uniflora		T	1	15								
Lupinus leucophyllus	20	14	21	9	3	6	3	32	1	3	2	11
Poa fendleriana	20	4	1		2	13	4	T	T	3	T	
Populus tremuloides	9	27	12	5	8	T	3	1		1	T	T
Potentilla pulcherrima	3	6	4	3	1	T	T	1				
Rosa woodsii	12	4	2	1	5	T	4	1	3	15	1	T
Stipa spp.	5	5	17	3	6	5	30	5	3	5	4	4
Symphoricarpos vaccinioides	4	12	17	7	12	18	18	10	T	2	2	1
Taraxacum officinale	10	6	1	1	15	3	T	3	1	2	T	1
Thalictrum fendleri									2	3	1	2
Others	3	4	3	3	13	15	17	10	T	2	4	2
CUT												
Total shrubs and trees	75	65	[1]--	43	10	10	--	6				
Total graminoids	15	15	--	4	50	60	--	46				
Total forbs	10	20	--	53	40	30	--	48				
Abies lasiocarpa		2	--	31		5	--	4				
Achillea lanulosa			--			1	--	T				
Agropyron caninum			--				--	1				
Astragalus bourgovii	T	1	--	3	1	1	--	T				
Bromus anomalus	4	3	--		1	1	--	9				
Carex spp.	8	8	--	T	31		--	T				
Castilleja linariaefolia	T		--	5	T	1	--	T				
Cirsium undulatum		1	--	16	T	1	--	8				
Erigeron speciosus	T		--				--	8				
Fragaria americana	T	1	--	T			--					
Frasera speciosa		T	--	11			--	T				
Helianthella uniflora			--	1			--					
Lupinus leucophyllus	4	6	--	11	15	10	--	30				
Poa fendleriana	T	3	--		10	40	--	25				
Populus tremuloides	68	40	--	5	5		--					
Potentilla pulcherrima	2	5	--	4	2	5	--	1				
Rosa woodsii	2	3	--	1	2	1	--	T				
Stipa spp.	1	1	--	4	3	6	--	6				
Symphoricarpos vaccinioides	5	20	--	6	3	4	--	2				
Taraxacum officinale	2	5	--	1	20	8	--	2				
Thalictrum fendleri			--				--					
Others	4	1	--	1	7	16	--	4				

[1] A dash indicates missing data.

Table 5.--*Changes in cover composition (%) of vegetation under 1.68 m in height on permanent 23.8 m^2 quadrats at Big flat between 1937 (3 years following establishment) and 1975.*

Understory vegetation	Closed to use				Deer use only				Deer and cattle use			
	1937	1942	1949	1975	1937	1942	1949	1975	1937	1942	1949	1975
UNCUT												
Total shrubs and trees	10	40	50	51	5	20	5	20	2	25	45	45
Total graminoids	50	25	15	5	35	35	55	22	52	35	35	15
Total forbs	40	35	35	44	60	45	40	58	46	40	20	40
Abies lasiocarpa	T	10	15	30	T	18	5	12	T	22	40	25
Achillea lanulosa	5	10	7	T	7	22	18	15	5	12	5	5
Agropyron caninum												
Astragalus bourgovii					24	15	15	10	10	10	5	6
Bromus anomalus												
Carex spp.	4	4	4	1	17	7	14	1	2	5	T	
Festuca idahoensis	45	18	10	4	17	15	24	5	50	28	34	15
Fragaria americana	22	5	1	3	24	5	6	7	25	10	5	6
Frasera speciosa	T	T	5	15			T	T			T	12
Helenium hoopesii	4	8	T	T					1	5	3	1
Lupinus leucophyllus			6	15				25				8
Picea engelmannii	T	10	10	1							T	5
Poa fendleriana					T	8	5		T	2	T	T
Populus tremuloides	10	20	25	20	5	2	T	8	2	3	5	15
Potentilla pulcherrima	T	3	4	2	T	2	T		T	1		T
Solidago decumbens	7	7	12	1	4		T		2		1	1
Stipa lettermani	1	3	1		T	2	1				T	
Taraxacum officinale	T	2	T					T				
Others	2	T	T	8	2	4	12	17	3	2	2	1
CUT												
Total shrubs and trees	50	55	[1]--	67	1	1	--					
Total graminoids	25	20	--	9	55	80	--	69				
Total forbs	25	25	--	24	44	19	--	31				
Abies lasiocarpa			--	5		T	--					
Achillea lanulosa	2	15	--	T	T	2	--	8				
Agropyron caninum	T		--		T	3	--	7				
Astragalus bourgovii			--				--					
Bromus anomalus			--	T			--					
Carex spp.	1	3	--	2	1	2	--	2				
Festuca idahoensis	23	15	--	7	54	70	--	45				
Fragaria americana	16	3	--	6	37	3	--	T				
Frasera speciosa	T	T	--	8		T	--					
Helenium hoopesii		T	--		1	3	--	15				
Lupinus leucophyllus			--	3			--	6				
Picea engelmannii			--			T	--					
Poa fendleriana			--				--					
Populus tremuloides	50	55	--	50	1		--					
Potentilla pulcherrima	1	1	--	T	2	2	--	T				
Solidago decumbens	1	1	--	2			--	T				
Stipa lettermani	1	2	--			5	--	15				
Taraxacum officianle	4	4	--	T	4	9	--	T				
Others	1	1	--	17	T	1	--	2				

[1] A dash indicates missing data.

uncut areas were compared to evaluate response of understory vegetation to grazing. Response of the cut areas is confounded by the initial elimination of aspen overstory by cutting and subsequent maintenance of the grazed openings through destruction of aspen suckers by deer. With the exception of aspen, species differences on the cut areas are more likely a result of continued lack of aspen competition than of direct utilization by deer.

The most striking difference in understory attributable to animal use was the great reduction in total shrubs (table 3). After 41 years, the ungrazed area at Grindstone Flat produced almost 10 times more shrubs than the area grazed by both cattle and deer and over 3 times more than that grazed just by deer. The graminoids increased under grazing at Grindstone Flat, but not at Big Flat. On both sites, cattle use apparently hampered total forb production, but deer use did not. Overall production of understory herbage was greatest on the areas closed to cattle, but grazed by deer. Deer browsing may tend to reduce the aspen overstory sufficiently to promote production of understory herbs, yet forb use by cattle appears to hinder overall understory production.

Most of the decrease in shrub production on the grazed areas can be attributed to the large reduction in snowberry. Of the graminoids, the sedges (*Carex* spp.) apparently decreased, but the presumably palatable fringed brome (*Bromus anomalus*) increased unexpectedly and appreciably on the grazed plots. Of the forbs, western yarrow (*Achillea lanulosa*) and milkvetch (*Astragalus bourgovii*) increased greatly under grazing, particularly where grazed by cattle. Velvet lupine (*Lupinus leucophyllus*) increased during the 41-year period on all of the permanent quadrats except on the uncut, ungrazed area on Grindstone Flat (tables 4 and 5). Production of both Wyoming painted-cup (*Castilleja linariaefolia*) and oneflower helianthella (*Helianthella uniflora*) was conspicuously reduced by deer use. Showy frasera (*Frasera speciosa*) appeared to be harmed by grazing at Grindstone Flat, but not at Big Flat.

Clearcutting aspen directly affected the abundance of certain understory species by altering light and moisture availability. An insight into environmental requirements of certain species can be gained by comparing the clearcut areas maintained as openings by deer browsing aspen reproduction and those that reverted to a dense stand of pole-size aspen (tables 3, 4, and 5). The effect of deer use on different plant species in the maintained openings can be discounted by examining the effect of deer use on the uncut areas.

Eliminating aspen cover greatly benefited the grasses, somewhat improved shrub production, and caused a decrease in production of forbs. As aspen reproduction developed into a dense pole-size stand on the protected clearcuts, cover of grasses declined and forbs increased.

The grasses responding most positively to removal of aspen cover were Idaho fescue (*Festuca idahoensis*) and the needlegrasses (*Stipa* spp.). Slender wheatgrass (*Agropyron caninum*), mutton bluegrass (*Poa fendleriana*), and bottlebrush squirreltail (*Sitanion hystrix*) also increased with clearcutting.

The only forbs that appeared to directly benefit by removal of aspen cover were Oregon fleabane *(Erigeron speciosus)* and orange sneezeweed *(Helenium hoopesii)*. Although velvet lupine increased on most areas, it increased less in the openings than in the closed stands, suggesting that lupine is favored by shade. Virginia strawberry *(Fragaria americana)*, on the other hand, declined on all areas over the 41-year period, but mostly in the openings, suggesting that it too is favored by shade. Fendler meadowrue *(Thalictrum fendleri)* also was favored by an aspen overstory. Interestingly, wavyleaf thistle *(Cirsium undulatum)* apparently was favored by aspen removal at Big Flat, but by a closed overstory at Grindstone Flat. This is not unreasonable for the 600-m elevational difference between the two areas could appreciably alter the insolation and available moisture relationships for this species.

MANAGEMENT IMPLICATIONS

Extrapolating results from these two small exclosure studies to broad management units is hazardous, particularly where animal behavior is involved. The exclosure results suggest that aspen reproduction on Beaver Mountain is doomed because of current levels of deer browsing. This is not true. The error of such a conclusion is readily demonstrated by ample reproduction of aspen on extensive burns within a few miles of the exclosures (fig. 4). Apparently, aspen suckers were so abundant over hundreds of hectares of mixed aspen and conifer stands that burned in 1958 that combined deer and livestock use did not hamper successful reestablishment of the aspen stands. Presumably, as these rejuvenated aspen stands mature and become less dense, ungulate use may again be sufficient to prevent survival and growth of the new suckers that periodically occur.

Figure 4.--A large 600-hectare area near Grindstone Flat burned in 1958 had ample aspen regeneration in 1975.

Sampson (1919) found that moderate use by cattle does not appreciably harm aspen reproduction in either standing timber or on clearcuts, but that sheep grazing can be very destructive unless it is light. Smith and others (1972) concluded from a study of four scattered sites in Utah that proper livestock management, especially management of sheep, is essential for regeneration of aspen following clearcutting or burning. They also concluded that the normal deer populations during the period of their study (1961 to 1969) had little effect on development of aspen reproduction in large clearcuts. Jones (1975) found that widespread and "appreciable" elk browsing of aspen reproduction on a 2-hectare clearcut in Arizona did not prevent establishment of a new aspen stand. On our study areas, however, deer use in both standing timber and in small clearcuts apparently was enough to keep suckers from developing into saplings and so prevented successful regeneration.

We believe that successful reestablishment of aspen on clearcuts or burns may be dependent upon the size of area treated, unless deer and livestock use can be rigidly controlled. Without control of ungulate use, clearcutting or burning less than about 5 hectares of mature aspen might be futile. Even if livestock are excluded from such areas for from 5 to 10 years, deer may concentrate on the small treated areas and prevent escape of the sprouts. Smith and others (1972) indirectly recognized this possibility by recommending that sufficiently large acreages be cut to provide an excess of aspen forage.

Our data suggest that use of the herbaceous understory in standing timber by cattle may alter the vegetation-competition relationships sufficiently to reduce mortality of young aspen suckers. This proposal is supported by data from Sampson (1919) showing that about twice as many suckers occurred on moderately and heavily grazed plots as on lightly grazed plots. Abundance of sucker production, however, is no guarantee of successful regeneration. Continued survival and subsequent growth of the suckers is affected by the intensity of ungulate browsing and rodent activity, disease incidence in wounded stems, as well as dieback from undetermined causes. Schier (1975) observed that such sucker dieback is common even in vigorous aspen clones.

A prounounced shift in species composition of the understory vegetation from forbs to grasses can be brought about by clearcutting aspen stands. This difference presists until the aspen overstory reforms and creates conditions more favorable for the forbs. Shrub production benefits somewhat by aspen removal, but not as much as the grasses do. If aspen suckers are not suppressed by browsing, succession back to forb dominance of the understory may occur within 10 years. Otherwise, the grasses will remain abundant as long as an aspen overstory fails to develop--unless, of course, the grasses are overgrazed by cattle.

In extensive areas of aspen, greater habitat diversity and improved forage conditions for both livestock and wildlife might be created by clearcutting small, scattered 2- to 5-hectare openings. These openings would favor the production of grasses for cattle and, at least for the first few years, aspen suckers as browse for deer. Deer utilization of the suckers in these small openings would prevent reestablishment of aspen and thus prolong grass production for cattle. Ideally, such openings would be created as part of an aspen timber sale program where a market for aspen products exists.

PUBLICATIONS CITED

Jones, R. J.
1975. Regeneration on an aspen clearcut in Arizona. USDA For. Serv. Res. Note RM-285, 8 p. Rocky Mt. For. and Range Exp. Stn., Ft. Collins, Colo.

Sampson, A. W.
1919. Effect of grazing upon aspen reproduction. U.S. Dep. Agric. Bull. 741, 29 p. Washington, D.C.

Schier, G. A.
1975. Deterioration of aspen clones in the middle Rocky Mountains. USDA For. Serv. Res. Pap. INT-170, 14 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Smith, A. D., P. A. Lucas, C. O. Baker, and G. W. Scotter.
1972. The effects of deer and domestic livestock on aspen regeneration in Utah. Utah Div. Wildl. Resour., Publ. 72-1, 32 p.

Mueggler, Walter F., and Dale L. Bartos
1977. Grindstone Flat and Big Flat enclosures--41-year record of changes in clearcut aspen communities. USDA For. Serv. Res. Pap. INT-195, 16 p. Intermountain Forest and Range Exp. Station, Ogden, Utah 84401.

The role of deer and cattle in the failure of aspen stands to regenerate on Beaver Mountain in southern Utah was investigated by a series of exclosures constructed in 1934. Three-fourths of each exclosure was clearcut of aspen in 1934. Aspen reproduction, shrubs, and herbaceous understory were measured in 1937, 1942, 1949, and 1975. Implications of wildlife and livestock use on aspen reproduction are discussed.

KEYWORDS: Populus tremuloides, clearcuts, aspen regeneration, understory vegetation, exclosures

Mueggler, Walter F., and Dale L. Bartos
1977. Grindstone Flat and Big Flat enclosures--41-year record of changes in clearcut aspen communities. USDA For. Serv. Res. Pap. INT-195, 16 p. Intermountain Forest and Range Exp. Station, Ogden, Utah 84401.

The role of deer and cattle in the failure of aspen stands to regenerate on Beaver Mountain in southern Utah was investigated by a series of exclosures constructed in 1934. Three-fourths of each exclosure was clearcut of aspen in 1934. Aspen reproduction, shrubs, and herbaceous understory were measured in 1937, 1942, 1949, and 1975. Implications of wildlife and livestock use on aspen reproduction are discussed.

KEYWORDS: Populus tremuloides, clearcuts, aspen regeneration, understory vegetation, exclosures

Headquarters for the Intermountain Forest and Range Experiment Station are in Ogden, Utah. Field programs and research work units are maintained in:

- Billings, Montana
- Boise, Idaho
- Bozeman, Montana (in cooperation with Montana State University)
- Logan, Utah (in cooperation with Utah State University)
- Missoula, Montana (in cooperation with University of Montana)
- Moscow, Idaho (in cooperation with the University of Idaho)
- Provo, Utah (in cooperation with Brigham Young University)
- Reno, Nevada (in cooperation with the University of Nevada)

☆ U.S. GOVERNMENT PRINTING OFFICE: 1977-0-777-023/33

NATIONAL FOREST SYSTEM · COOPERATIVE FORESTRY · FORESTRY RESEARCH

FOREST SERVICE U S DEPARTMENT OF AGRICULTURE